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Curriculum Ideas for Teachers

1981

This support document to *The Formative Years*, one of a series dealing with the conservation of energy, provides information, student material, and suggestions to teachers for presenting this topic in the Junior Division.

What Is Energy?

Energy
J5

Titles in this series are:

Water and Energy (J1)
Food and Human Energy (J2)
Clothing, Shelter, and Energy (J3)
Transportation and Energy (J4)
What Is Energy? (J5)
Air, Space Heating, and Energy Conservation (J6)
Manufacturing, Services, and Energy (J7)
Sources of Energy (J8)

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Introduction

This unit has been designed in such a way as to deal, one at a time, with some of the various forms energy takes. The approach is simple and straightforward so that the complexity of the subject is alleviated.

The first and last activity sets are essentially an introduction and a summary, respectively. The other seven activity sets relate directly to specific energy forms. Those forms that students can sense (see, hear, or touch) are considered first. The more difficult abstract forms follow later. The concept of energy conversion – the fact that energy can change from one form to another – is introduced in Activity Set 6.

It is recommended that the activity sets be completed in the sequence presented. However, the amount of time devoted to particular activity sets could vary markedly. One possibility is to assign the seven forms of energy to seven different groups and attempt some student leadership in instruction. This would have to be planned and supervised carefully, since the student activity sheets alone do not necessarily represent adequate instructional tools for covering the topics.

The follow-up and related activities in each activity set are for consideration and possible extension of the main student activity. Your own experience and skill will dictate when to take advantage of these suggestions or when to modify them to suit your own situation.

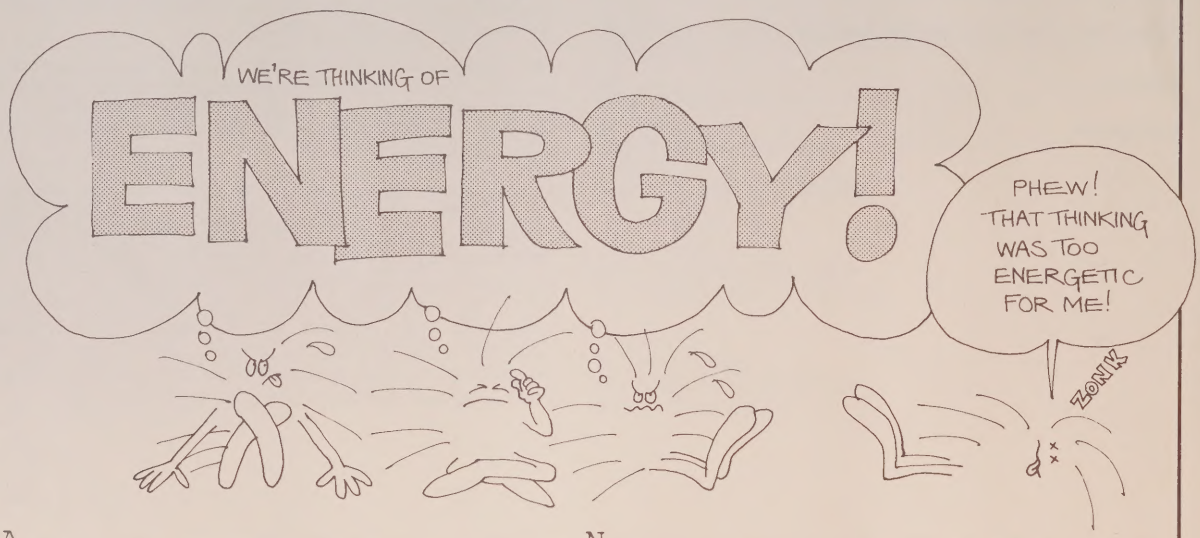
Energy is a nebulous topic. An introductory level of understanding of it is probably all that one can hope for. At the completion of this unit, the students should be able to address the question "What is energy?" with some insight into the various forms and conversions of energy. Undoubtedly, their comments on energy will not be as simple and precise as the formal definition – "the ability to do work". However, a memorized definition that means nothing to students seems purposeless, and they will get a chance in later grades to broaden their knowledge regarding the various theories related to the fundamentals of energy.

Name:

Energy Words

Close your eyes for about thirty seconds and think hard about one word that you have probably heard many times before - "energy".

When you think about energy, things come to mind that energy reminds you of. In the spaces below, beside the letters of the alphabet, write down words you think of when you think of energy. Any word written in a space must start with the letter beside that space. Can you think of one energy word for each letter of the alphabet? If you can't think of a word starting with any one letter, go on to the next letter.



A _____ N _____

B _____ O _____

C _____ P _____

D _____ Q _____

E _____ R _____

F _____ S _____

G _____ T _____

H _____ U _____

I _____ V _____

J _____ W _____

K _____ X _____

L _____ Y _____

M _____ Z _____

Notes

This activity might be called an alphabet word-association activity. It encompasses the following:

– It uses the alphabet as a means of organizing information.
– It involves vocabulary skills and word associations.
– It can be used to assess student awareness of ideas related to energy.

The activity forces students to concentrate their thinking on the words most central to the unit. In brainstorming fashion students should pour out their ideas in terms of words that relate to energy. To ensure some success the following preparatory activities are recommended:

1. You could demonstrate word association by supplying a few examples of your own, such as "bird – feathers", "white – black", "cookies – good". Have the students test you with a few words.

2. Do a fast-paced word-association exercise verbally. Pick students one at a time and give them each a word.

3. On a chalkboard, write down the letters "A", "B", and "C" in a short list and draw a line to the right of each letter. Then have your students give you words starting with the letters listed that they associate with the word "animal". Write down a few words for each letter, making sure to include some non-noun words. This drill should illustrate that all parts of speech are acceptable in this activity.

Now distribute the activity sheets and have the students start, individually or in groups of three or four. Set a time limit of about ten minutes for the activity. As an aid, you could cut out a large "ENERGY" word sign to hang at the front of the room as a focus for students during the activity. If you expect some students to have trouble, or to finish early, have some scrambled energy words on the chalkboard for them to unscramble. Examples are "nsu" (sun), "oalc" (coal), "lio" (oil), "thea" (heat), "libo" (boil), or "urbn" (burn).

Follow-up Activities

1. Start with the letter "A" and ask students, in turn, to give a word for each successive letter. (These could be written on the chalkboard.)

2. The students could determine their own energy word score (calculate one point for each word listed) as a means of increasing interest.

3. Have the students pick out the following:

– the "best" word;

– the most puzzling word;

– the most interesting word;

– the word they know the most about; or

– the word they know the least about.

Have some students give the reasons for their choice to the class.

4. As a team activity, select certain letters and ask teams of three or four students to try to come up with as many words as possible that not only start with that letter, but also contain the letter.

5. Select related pairs of words from the students' lists and ask the students to express the relationship in a sentence. For instance, if "sun" and "coal" are selected, the sentence could read: "Coal was formed from plants that grew a long time ago, using energy from the sun." As an alternative you could draw a line to connect word pairs in a list of your own on the chalkboard. Students would then have to write a sentence for each pair, illustrating a connection between the words.

6. Divide the class into perhaps eight work groups. Have the completed activity sheets cut up along the dotted lines so that each group receives all the words for one set of letters. Each group would then tally all the words for each letter in its letter set and arrange them according to how frequently they are repeated. For instance, under "O", group five might tally "oil" (20), "odour" (1), "open" (1), and "oven" (1). Group five would also do a tally for "N" and "P" words. This would show the number of times that different words appeared. A single master copy of all the words from the groups' tallies could be duplicated. It could be entitled "Our Starting Vocabulary". New words learned during the unit could be added later if room were left on the right-hand half of the page for "New Words".

Related Activities

1. Have your students play the Round Robin Word Game. Each student selects three words from a prepared list of energy words to research and explain to the class. You start the game by explaining one word from the list. You then pick a student to do the next explanation. The student asks "Which of my three words would you like to hear about?" You pick one and the student explains it. The student then picks another student to continue the game, and the game goes on from there.

2. To practise dictionary skills, have students choose a letter of the alphabet and then search out ten or twenty words related to energy that start with that letter. They should include short explanations for each word they choose.

3. Students could classify words from the prepared list related to energy under categories such as sources, uses, or types. The classification could also be done according to whether the words are nouns or adjectives (or "things" and "words that describe things").

4. Have students write a one-page story using as many words related to energy from a prepared list as possible. The words from the list should be underlined in the story.

Name:

6

Motion Words

If an object is moving, it has a type of energy known as kinetic energy.

In the pictures that follow, different things are seen in motion. Use motion words to describe each thing that is illustrated. (Words like "speeding", "crawling", or "falling", are examples of motion words that indicate the presence of kinetic energy.)

a bird _____ a person _____ a car _____

or _____ or _____ or _____

Think of things that are often described by each of the following words. Remember that each of these things has kinetic energy when it is moving.

Motion Word	Things
crawling	babies, insects, spiders
falling	
sliding	
jumping	
swirling	
rolling	
speeding	
sailing	
prancing	

Notes

Of all the forms that energy takes, kinetic energy, or energy of motion, would seem to be the easiest to recognize. If an object moves, then you know it has kinetic energy. It is that simple.

It is possible to talk about kinetic energy without getting into measurement and equations. In fact, for Junior Division students, it is essential to avoid too much complexity. For this reason, a language-oriented activity has been developed here.

"Motion words" can be defined for the students as "words ending in *ing* that describe movement". The focus of the activity is on making students aware that we regularly use a great number of such words in our speech.

First, the students are asked to observe the series of three pictures on the activity sheet. They must then determine what "motion words" would be appropriate to describe the action shown in the picture. For a bird, answers could include "moving", "flying", "gliding", "soaring", or "flapping". For a person, "jogging", "running", "walking", "skipping", "jumping", "speeding", and "striding" could be used. For a car, "speeding", "moving", "swerving", "racing", or "running" are all appropriate.

The point to be noted is that we recognize motion in many things. We talk about it all the time. But we do not talk in terms of energy. We use "motion words" instead of the technical term "kinetic energy".

The second part of the activity sheet is designed to illustrate the number of things that at some time or other do have kinetic energy.

Follow-up Activities

1. From a collection of magazines, have students cut out pictures that illustrate as many of the motion words in the class list as possible.

2. After discussing in simple terms the fact that kinetic energy is determined by both an object's mass and its speed (velocity), have students prepare two lists. One list should include descriptions of objects having a small amount of kinetic energy (e.g., an ant walking). The second list should include objects having a large amount of kinetic energy (e.g., a bullet in flight or an elephant running).

3. Have students add verses to the following poem entitled "Looking for Kinetic Energy":

Look for –
wooden bats swinging,
white balls flying
desperate players sliding,
scattered dust rising,
when there is motion in *a baseball park.*

Look for –
graceful birds soaring,
tiny insects squirming,
nervous mice burrowing,
an angry moose charging,
when there is motion in *the wilderness.*

The format in each verse is to use an adjective and a motion word to describe four different things that someone could "look for" in the place mentioned. Other places for students to consider include the classroom, the hockey rink, the highway, the playground, their bedrooms, their houses, the store, the gas station, the school hallway, and the gymnasium.

4. Have students pantomime "a speeding bullet", "a snail's pace", "greased lightning", "as slow as molasses", and as many other phrases related to motion as they can think of.

5. Have students write an action sentence, paragraph, or story including as many motion words (these should be underlined) as possible.

6. From your school board's film library obtain theme films on such topics as skateboarding, surfing, or skiing in order to demonstrate to your students how people incorporate kinetic energy into recreational activities.

Related Activities

1. Have students take a kinetic "energy hike" in or beyond the schoolyard to identify things that are moving and motion words to describe them.

2. Set up a "miniature pool table study". You will need glass marbles and a flat, preferably smooth surface. The idea is to have students study the transfer of kinetic energy between objects by observing and describing what happens when:

– one marble strikes another head on;

– one marble hits another at an angle;

– one marble hits two others at the same time;

– a large marble moving slowly hits a small one at rest;

– two marbles moving in opposite directions hit head on;

– a marble travels over a not-so-smooth surface (covered with sand or salt).

4. Have students bring toys such as "hot wheels" from home and devise experiments to observe how slopes affect the kinetic energy of objects that are moving under the force of gravity.

Name:

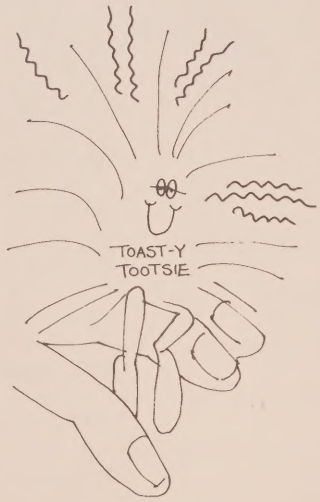
Heat-Hunting Detective

If you are a pretty good detective, you should be able to track down the heat takers in your classroom. Heat takers are objects that take heat energy from your fingertip when you touch them.

During your hunt, you may also come across some heat givers. But beware, a heat giver that is very generous to your finger could also be painful. So watch out! This is a very touchy bit of detective work.

List five or more takers and five or more givers. Describe how much heat each took from or gave to your finger.

Heat Takers	How Much (a little, a lot)
1	
2	
3	
4	
5	



Heat Givers	How Much
1	
2	
3	
4	
5	

Notes

To understand what heat really is involves some discussion of atoms and molecules. If you don't wish to tackle a simple explanation of the molecular basis of heat, skip over the next few paragraphs. Whatever you decide to do, remember that the information that follows is intended for you, not your students.

You must first realize that molecules are in constant motion, even in something as solid as iron or steel, although this motion occurs on a scale so small that it is impossible to see with the unaided eye. Thus, molecules in all things have kinetic energy by virtue of their movement. They vibrate, gyrate, and oscillate continuously. This form of energy in molecules is called "thermal energy".

Thermal energy will increase in any object if the molecules are excited or caused to vibrate and gyrate faster. A simple word for this is "heating".

For example, heat will transfer from a relatively "hot" substance brought into contact with a "cooler" substance. Some of the energy from the "hot" molecules will be transferred through collisions to the molecules in the cooler object, making them vibrate faster. The cooler object is heated, and at the same time the hotter object is cooled.

This is a technical or scientific explanation of heating and cooling. Quite often heat is lost from objects directly to the air molecules surrounding and touching their surface. In this case, the air molecules near the hotter surface come in contact with the faster, vibrating surface molecules. The collisions among molecules along the surface cause the "heating" of the air (the air molecules receive kinetic energy and move faster).

It should be recognized that when air is warmed, it expands. The expansion is a result of the increased movement in the air molecules. The more frequent collisions tend to push the molecules farther apart.

Convection results when expanded warmer air (which is also less dense) rises above the denser, cooler neighbouring air. The transfer of heat energy to a liquid may result in convection.

When heat energy is transferred between solids, the process is called *conduction*. In solids, the molecules vibrate about fixed spots. They cannot flow as they do in air or water and carry heat energy away by convection. However, they can pick up energy and pass it along to the molecules next to them. Heat energy can therefore travel through something solid in a manner akin to a chain reaction. Molecules excited at one end transfer the added thermal energy along by colliding with the molecules beside them from one end of the solid to the other.

Some solids conduct thermal energy faster than others. Hold the tip of a nail in boiling water and it doesn't take long for the end you are holding to get quite hot. Hold a pencil tip in the boiling water and little if any extra heat will reach the end you are holding. Most metals are good heat conductors. In the case of the nail, the iron molecules quickly transfer the added thermal energy (received from the fast-moving boiling-water molecules) from the tip of the nail to the end you are holding.

The activity sheet is designed to encourage your students to become active, inquisitive, and investigative. A good assortment of heat takers already exists in the classroom. Glass windows, large metal objects at room temperature, and large bottles at room temperature are all examples. When you touch these objects, you should feel something cool. What a student should realize is that when he/she touches a "heat taker", the feeling of coolness is actually the quick transfer of heat from the tip of his/her finger to the object. The finger is "robbed" of its heat energy, and a cooling effect is felt.

Some substances like metal and even glass transfer heat energy somewhat more quickly than other substances. We call them good heat conductors. Other substances like wood, paper, styrofoam, and cloth are poor conductors and take away heat slowly. You might expect metal at 20°C and cloth at 20°C to "feel" equally cool. This is not the case. The metal, because it is a good conductor of heat energy, will take energy away from your finger relatively quickly. The cloth, being a poor conductor, will take energy away, but so slowly that your sensors may not notice. By definition, most poor heat conductors are good heat insulators.

When you touch a "heat giver", the sensation of hotness is actually the result of the quick transfer of heat from the object touched to the tip of your finger. Testing for "heat givers" in the classroom should be done with appropriate caution. Make sure you carefully test everything in the classroom first, and warn your students what not to touch. If some items are too hot or dangerous, put up red signs saying "Don't touch this."

Make available in the classroom a variety of heat givers and takers. An assortment like the following should guarantee a good investigation:

- a bottle filled with ice water;
- a balloon filled with cold water and placed on a plate;
- a different-coloured balloon containing warm water;
- a (sealed) thermos containing very hot water;
- a lit 25 W light bulb;
- a frozen "hot dog";
- a warm cup of tea;
- a hair dryer (turned on);
- an electric razor and other small electric appliances (turned on).

After the activity, make a chalkboard list of the students' findings and try to pick out the "strongest" heat takers and givers. Try to communicate the idea that feeling heat and cold is actually sensing heat energy coming to or leaving the surface of the skin, and that this may depend on the type of material (conducting or insulating) in the object.

Follow-up Activities

1. Have students write about or discuss things that are dangerous to children because of the amount of heat energy they can give off. Some students might relate personal experiences. (The aim of this activity is to try to instil caution in students in their day-to-day exposure to heat energy.)

2. Have students work in small teams equipped with catalogues of household appliances and home tools. Have them cut out pictures of items that are either designed to give off heat or that the students think give off heat incidentally (as do the motors of most electric appliances, for example). Have them pick out two or three that they consider the most dangerous from a heat energy point of view.

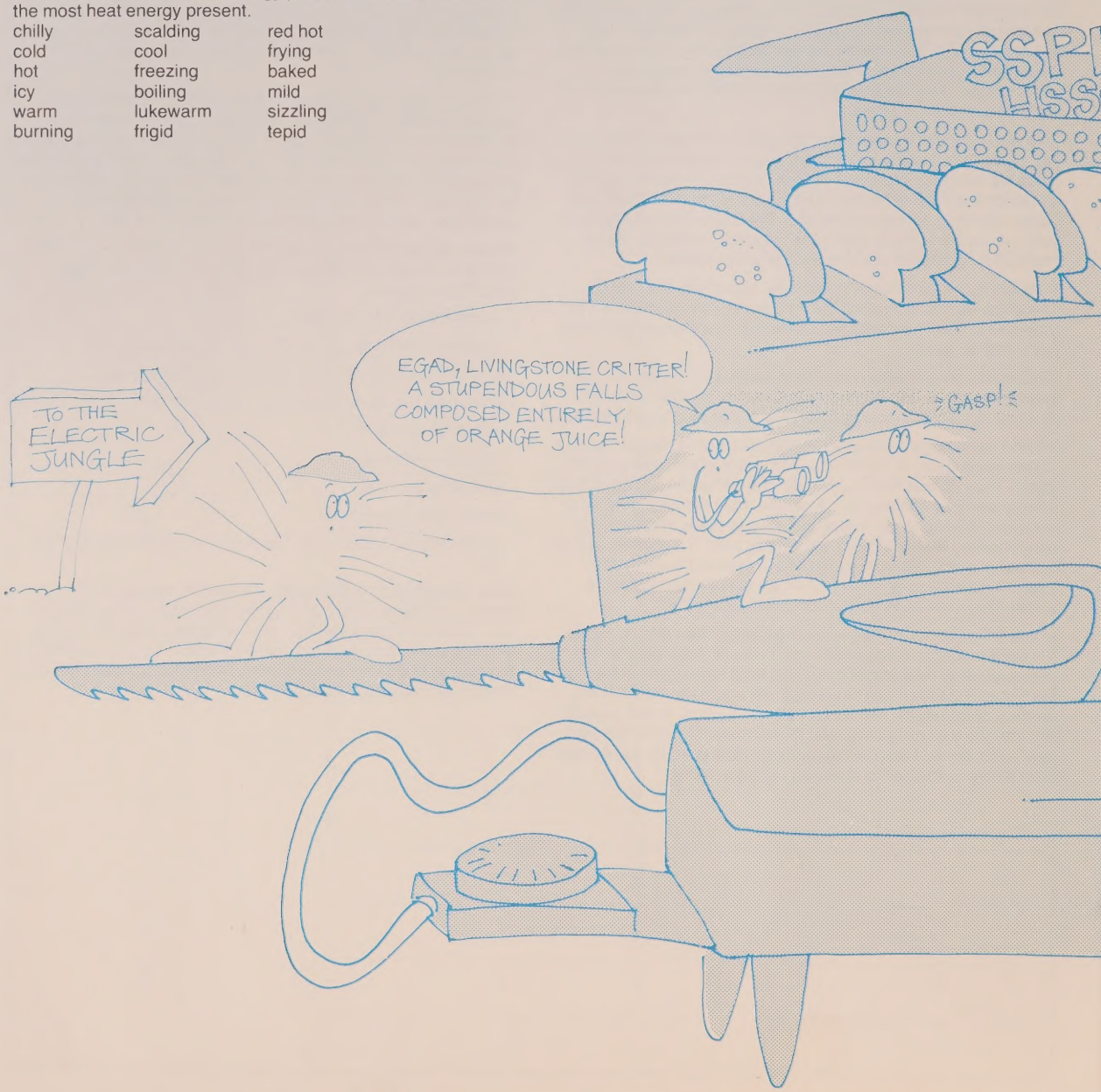
3. Have students think for a moment about words that suggest a specific degree of heat energy. Have them reorder the words from the following list to suggest a ranking beginning with words that indicate the least heat energy present to those that indicate the most heat energy present.

chilly	scalding	red hot
cold	cool	frying
hot	freezing	baked
icy	boiling	mild
warm	lukewarm	sizzling
burning	frigid	tepid

Related Activities

1. To investigate the conduction of heat by various substances, situate a pot containing very warm water (not hot enough to harm if spilled) in a suitable place for demonstration. Have students touch the side of the pot without any protection. Then have them touch the pot using a variety of conductors and non-conductors between their fingertips and the pot. The following objects can be used: tin foil, a rubber glove, a mitten, a tea cozy, a piece of paper, twenty pieces of paper, styrofoam from a cup, a wet mitten.

2. Bring in a number of cups and glasses made of different materials (e.g., styrofoam, glass, plastic) and place the same amount of near-boiling water in each. Emphasize that to begin with all of the containers are equally hot. After thirty minutes and again after an hour have students measure the temperature in each container to see which has kept the water hottest (prevented the loss of thermal energy).



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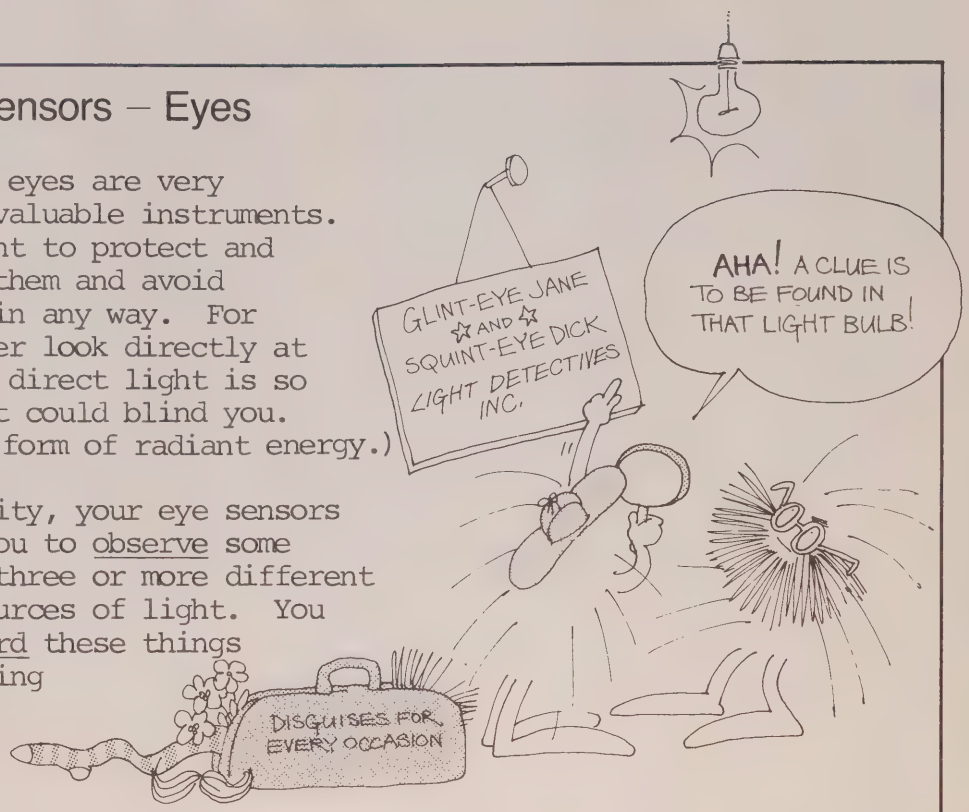
Name:

The Super Sensors – Eyes

You know your eyes are very delicate and valuable instruments. It is important to protect and take care of them and avoid harming them in any way. For instance, never look directly at the sun. Its direct light is so strong that it could blind you. (Light is one form of radiant energy.)

In this activity, your eye sensors will enable you to observe some things about three or more different artificial sources of light. You can then record these things in the following chart.



Name the source.	Describe the colour of the light.	Describe how bright the light was.	Describe the exact spot that the light seemed to come from.

Notes

Radiant energy can take on many forms, and one of these forms, visible radiant energy or "light", can be sensed with our eyes. For this reason it is the main focus of attention in the student activity. However, the activity does not attempt to teach anything about the physical basis of light because of the complexity and theoretical nature of the subject.

The purpose of this activity is to study light as one example of radiant energy, and to identify the sources and characteristics of everyday examples of "visible radiant energy". If your students also note a connection between the heating of substances and the creation of light energy, you will have achieved all that might be expected. The following background information is included for your interest. Do not expect to convey these abstract ideas to your students.

One theory about the nature of light suggests that radiant energy is energy carried in electromagnetic waves. The complete theory is too complex to be given here, but it can be obtained from physics texts. The earth receives most of its radiant energy from the sun.

Our eyes are only able to respond to one form of radiant energy. We call that form "light". Other forms of radiant energy exist that we cannot sense with our eyes. These include radio, ultraviolet, X-ray, infra-red, micro-, and other waves. Although we can't see these types of radiant energy, we do have machines and materials that are sensitive to them. One example is the film used in X-ray machines.

Radiant energy does not require a medium in which to be carried. It travels through the emptiness of outer space at tremendous speeds (about 3 000 000 000 m/s). One type of radiant energy is theorized to be different from the next as a result of the length and frequency of the electromagnetic wave. For instance, radio waves are a form of radiant energy with a wave length between approximately 100 m and 1000 m long. TV waves are between 10 cm and 1 m long. Visible light energy waves are less than one-thousandth of a millimetre long.

One can be more convinced that these "waves" do in fact represent an energy form when one considers the heating capabilities of "microwaves" in microwave ovens, the infra-red waves from a heat lamp, or the ultraviolet waves from the sun that cause sunburns. As well, much of the heat we feel from a campfire or fireplace is radiant energy absorbed by our skin and converted to molecular kinetic energy that we feel as heat.

Since the sun's radiant light energy is not available to us everywhere (e.g., in windowless rooms) or all the time (e.g., at night), we have found and developed ways to create radiant energy from the things in our world. Your students could be taken to a very dimly lit room where an effort has been made to exclude as much stray light as possible. A single light source might be used to assemble the students in a circle on the floor to observe the demonstrations.

Give students some time to get accustomed to the darkness and explain the requirements of the activity – to observe and record information on various forms of visible radiant energy. Then start a series of demonstrations to show radiant light energy being given off. The following are some possible choices of things to use:

- a match
- a piece of smouldering yarn or cotton cord
- the elements of a toaster
- a portable winter car heater
- a short, twisted, burning piece of paper (held over a bowl of water for immediate dowsing)
- an element of a small burner heated to turn red
- a non-frosted colourless glass light bulb of low wattage (no greater than 60 W)
- an electronic flash from a camera or a flashbulb
- a filmstrip projector shown on a screen

Do not use a candle in this activity as it is an important component of a later activity.

Please note that the order in which things are observed is important. Very bright objects, such as light bulbs or electronic flashes, should be viewed last because of the image that remains after viewing them.

At the completion of the observations ask the students, "What other energy form was often present each time light was produced?"

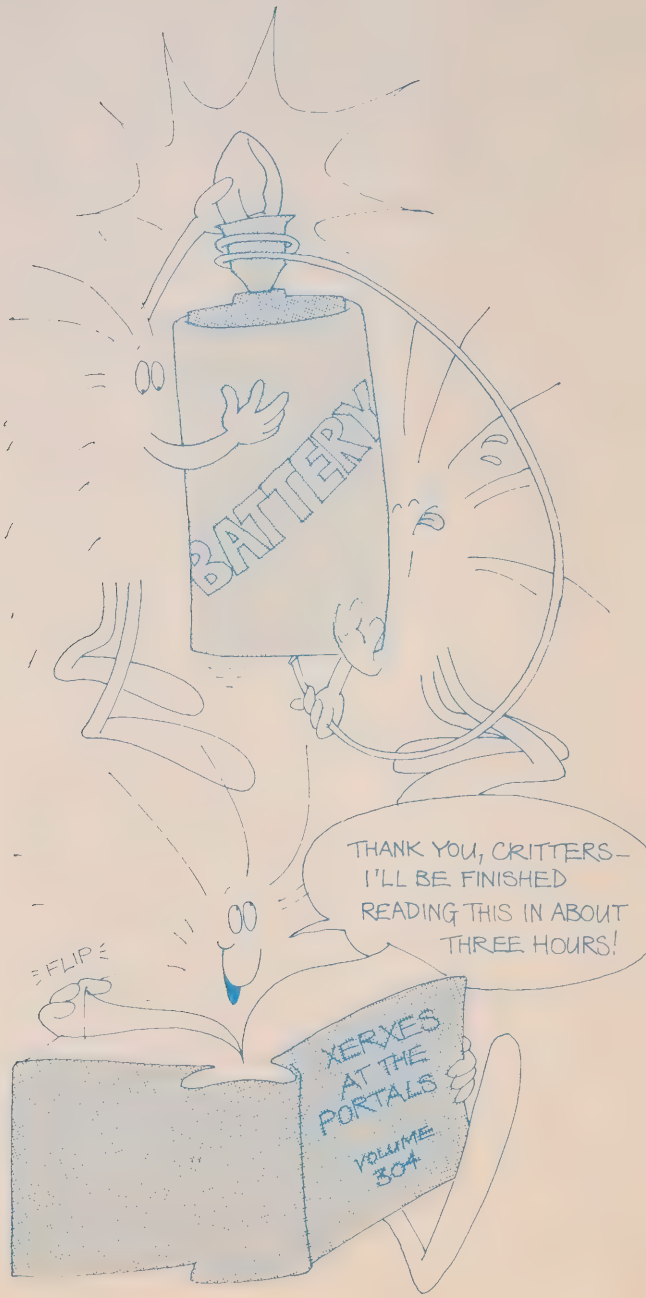
Absorption of light is easy to demonstrate through experiments. Everyday examples of absorption of radiant energy have been experienced by most students. The hot surface of asphalt in summer and the hot water in a garden hose that has been left in the sun are examples. The related activities suggested on pages 14 and 15 offer some suggestions for further demonstrations and experiments.

Follow-up Activities

1. As a demonstration activity, take your students into a slightly darkened room and turn on a lamp (without a shade) containing a clear, non-frosted light bulb. Hold a hand magnifier alongside the bulb and attempt to focus the image of the bulb's glowing white filament on the wall, on a piece of paper, or on any surface. (The distance from the bulb to the magnifier should be approximately one-tenth the distance to the projection surface.) This is one way to view the source of the light from a light bulb without looking directly at it. The image of the coiled white hot filament will appear.

2. Have students observe the glowing filament in a flashlight bulb. They can set up their own apparatus by using three or more dry-cell batteries of different sizes, a small flashlight bulb, and a piece of thin copper wire. The wire is looped around the bulb, and the contact point of the bulb is brought into contact with the top of the battery. The loose end of the wire is then brought into contact with the bottom of the battery. At this point, the filament should glow. By using different dry-cells students can change the intensity of the light, as well as the heat produced. Following their experimentation, students might attempt to list some conclusions about the effect of larger and smaller batteries on light and heat.

How to Light Up a Flashlight Bulb



Related Activities

1. Demonstrate to students how hand magnifiers can be used outside to concentrate the radiant energy of the sun. You will need hand magnifiers, pencils, and test objects such as the following:

– white tissue or toilet paper

– white writing paper

– a popsicle stick

Each test should involve focusing the sun's rays on a pure white section of the object and on a darkened section formed by rubbing a pencil over the white area. (Invariably the darkened surface will smoulder faster because the dark surface absorbs more radiant energy than the light surface. Note that the graphite is not flammable. It simply darkens the object.)

Note: Students should be warned about the serious danger of permanent eye injury caused by looking directly at the sun through any magnifier.

2. Provide students with two identical containers, one painted flat black and the other white or silvery. Have them fill the containers with equal amounts of water at the same temperature. The two containers are then placed 10 cm from a lit 100 W light bulb. Have students record the temperature of the water every fifteen minutes for two hours to see the difference in absorption by the two surfaces.

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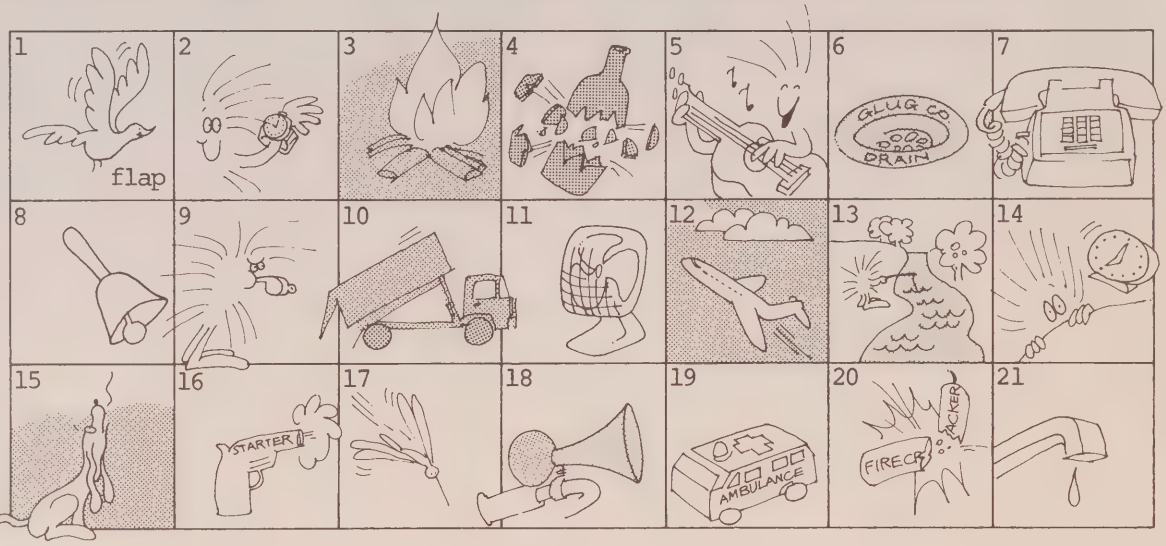
Name:

Sound Energy – Wanted or Unwanted

We hear and enjoy some sound energy, such as the sound energy from musical instruments. We make some sounds to communicate with others. Animals share our need to make sounds to send messages. Such sounds have a purpose.

In the pictures below, about half the things shown make sounds with a purpose. The others make a kind of noise - that is, sound without purpose.

Find the things that make noise and cross them out. For each of the remaining boxes write a short sentence to describe the purpose of the sound created. Make up a word to describe the sound and write it in the box. Number one has been done as an example.



Notes

As is the case for other forms of energy, an explanation of the physical basis or interpretation of sound energy is probably best left for the Intermediate or Senior science program. For your own understanding, some background information follows, but it is not essential to the activity.

Sound emanates from things that vibrate. A vibrating object has kinetic energy due to the motion of the object back and forth. The string on a guitar receives potential energy when it is pulled from its resting position. When released, this energy is transferred into the motion of the vibrating string.

Air surrounds most things with which we are familiar. We cannot see the air vibrating next to the guitar string, but we can infer that it must be happening. The molecules of air act as a medium for transporting the sound energy. In chain-reaction fashion the molecules vibrated first hit the ones next to them, and in this way the energy spreads in all directions. Unlike water waves on the surface of the water, sound-energy waves are three-dimensional, moving in all directions at once. They move fairly quickly, travelling at about 330 m/s. (In water, vibrations travel even faster, at about 1500 m/s.) Just as our eyes can respond to certain forms of radiant energy, our ears can pick up vibrations in the air, although only within certain limits. The range of vibrations that we hear is called the audible spectrum.

The focus of the activity is not on the physical basis of sound energy. Rather it is on sources of sound that we can sense. The activity uses a simple classification of sounds, in which noise is contrasted with sounds made with a purpose.

The day on which this activity is carried out should be filled with sound. You should probably have on hand a radio, a tape player, an alarm clock, a whistle, a couple of musical instruments, a hair dryer, an electric shaver, a blender, a horn, a bell, and a whole assortment of other items that can be used to make noises or sounds with a purpose.

Start the activity by making some unpleasant noises such as scratching the chalkboard, slamming the door, breaking a balloon, or sliding your desk across the floor to cause it to screech. A definition of noise might be attempted by the students, and a dictionary definition should also be found. As well, the fact that some sounds are made with a purpose should be noted.

After this preliminary discussion concerning types of sounds, review what is represented in each picture. The students should then be able to complete the activity. Depending on the definition of noise agreed upon, the boxes that might represent noise are #2, #3, #4, #6, #10, #11, #12, #13, #17, and #21. The remaining boxes, including #16 and #20, might be considered "purposeful", although these two are debatable. The gun represents a starting gun in a race. Number 20 represents an exploding firecracker.

As a concluding statement to the activity, it should be noted that all sounds, whether they are made with or without a purpose, involve the release of sound energy. You may wish to define all sound-energy sources as things that vibrate. Even a breaking glass momentarily vibrates as it breaks apart, giving rise to the sounds we hear. Vibrations are the source of all sounds.

The question then is how do the vibrations reach our ears – our sensors? You could explain that the tiny particles (molecules) that make up the air around us carry the vibrations. To go beyond such a simple explanation of sound-energy transfer is probably beyond the level of understanding of most of your students.

Follow-up Activities

1. With your students make a list of various sources of noise. To help them with ideas, suggest that they imagine themselves in other locations such as a garbage dump, a factory, a car repair shop, a furnace room, a railway yard, or an airport.

2. Have students construct sound-makers or hold a sound-making contest using either a limited or unlimited supply of materials. A limited supply would involve materials that are only available in the classroom. An unlimited supply could involve sound-makers brought from home. Judge each sound, using different categories, such as best soft sound, most unpleasant sound, longest sound, or lowest or highest pitched sound.

3. Discuss with your class the idea that sound comes from vibrations by checking some sound-producing objects to see if there is motion present. Musical instruments would be useful here.

Related Activities

1. Take students outside to work in groups of three in the schoolyard. One student is blindfolded, one is the leader, and the third is the sound-maker. The leader takes the blindfolded person to two different places. At each place three sounds are made by the sound-maker, using objects that are found in the area. The blindfolded student must describe and/or guess what is causing the sound. The idea is to get a perfect score of six correct. Have students change roles if time permits.

2. Take your class on a visit to the boiler room in your school or to some place where heavy equipment produces numerous unwanted sounds. After you return to the classroom, discuss with the students what was heard.

3. Have students consider or research how sound can damage a person's hearing through, for example, the loud sounds that are found in some work places, or the sounds produced at a "rock concert".

4. As a language arts activity, have students write a paragraph using as many descriptive "sound" words as possible to discuss what would be heard (a) at such locations as a car wash, a bus depot, a train station, a laundromat, a shopping centre, a lake, a forest, a farm, a dance, a beach, or a school classroom or (b) during a blizzard or a rain storm.

5. Have students ask their parents to show them the bass speaker in their stereo. Suggest to the students that they watch the bass speakers when bass-enhanced song music is played. Have them write a report of what happens.

References

Aikman, J. A. *Sound*. Toronto: Macmillan of Canada, 1975.

Scott, Douglas R. *Light and Sound*. Toronto: Holt, Rinehart and Winston of Canada, 1975.

Name:

Visitors From Outer Space

Pretend that you are a visitor from outer space. Your one mission on earth is to learn more about energy. Energy is running out on your planet and you need to find more. So far your "people" know about the energy that you have seen (motion energy and light). You can hear (sound energy) and you can feel (heat energy), because you have sensors for these things. However, you do not know about the mysterious energy in some things.

The human race on earth selects a wise person to try and show you, through your sensors, that energy exists within things.

You are shown a candle, something you have never seen before. Use the spaces below to record what you observe.

	Can you see it give off light energy?	Can you see energy of motion?	Can you hear sound energy?	Can you feel heat energy?
	If any answers are yes, describe the energy observed.			
Before the Change				
After the Change				

What would an outer-space visitor conclude about energy after having seen the candle burn?

Notes

Having dealt with energy forms that are identifiable by virtue of our ability to sense (see, hear, or feel) them, we are left with more difficult forms. In an unaltered condition these forms of energy cannot be sensed. Only through a process called "conversion" can we sense them.

Many materials contain what a student might refer to as "the potential or stored energy within the substance". We will give this form the name "chemical energy". Chemical energy exists by virtue of the arrangement and characteristics of the atoms and molecules making up a substance. Our dependency on chemical energy is made obvious when we consider substances such as oil, coal, wood, gasoline, and paper. Most substances we recognize as major sources of energy turn out to be chemical-energy-rich organic substances (essentially substances formed from living things). Although it is incorrect to say that only organic substances can supply chemical energy, the simplified treatment that follows discusses only these sources.

Plants have been by far the main agents in storing chemical energy. The process of photosynthesis enables plants to convert the radiant energy of the sun, with carbon dioxide and water, into complex energy-storing compounds such as sugar and starch. This energy storage occurs as a result of the arrangement of atoms and the creation of chemical bonds which are the energy "storage sites" in the new compounds. These compounds (chemicals) provide energy on demand within the cells of plant tissues.

The energy stored in plant molecules furnishes the energy required by animals for their life processes. We refer to our intake of this energy as food. Of course, various nutrients are also ingested, but energy is the key feature of our link to plant life and, ultimately, to the sun.

When we look more closely at the molecules of living things, we see that the carbon atom is a major "building block". Together with hydrogen and oxygen atoms, and trace amounts of a host of other atoms, carbon is the key ingredient that makes possible the tremendous variety of organic substances (those molecules formed by living things). (Remember that radiant energy from the sun is instrumental in the "building" of all organic molecules.)

Most foods contain numerous carbon atoms useful in storing energy. When food is digested, this energy is reshaped and transported to either a storage site (e.g., a fat deposit), or to an energy-conversion site (e.g., a muscle), where chemical energy is converted to heat and motion in order to carry out the workings of the body.

Oxygen is particularly important in releasing energy from organic molecules. In the highly controlled conditions of plant or animal tissues, the reactions that result in the release of chemical energy happen in the presence of oxygen. They are happening all the time, but the individual reactants are so small and the reaction so localized that they go on relatively unnoticed. (Our body heat is an indication that energy is being released.) In contrast, in the rather uncontrolled conditions of a forest fire or a campfire, the release of chemical energy in the form of light and heat is dramatic.

Success in finding ways to exercise control over the burning (conversion) of organic substances in order to make use of the chemical energy they store has been, perhaps, the single greatest achievement of the modern era. The great energy reservoirs called fossil fuels have been the energy sources used to drive engines that powered the first steamships, locomotives, automobiles, airplanes, and rockets. The coal-fired steam engine and the gasoline-powered piston engine brought on a revolution in technology. Our dependence on the chemical energy in fossil fuels, whether to drive our vehicles, run our industries, or heat our homes, continues to be relatively great, but our dependence on the chemical energy in food is total.

Although the exact nature of chemical bonding and the energy factors relevant to molecules have been left for the secondary school chemistry class, chemical energy cannot be overlooked. It is too important. In your class you can call it the energy stored in certain types of substances and you can make the link to plant life. Many of our everyday items can be traced, as wood or fossil-fuel products, back to plants. The success of the activity sheet depends on how well you can establish the mood of the situation being portrayed. There is a great deal of make-believe involved.

The students must try to respond as outer-space visitors would if they had never seen a candle before. In its unaltered state, a candle appears to possess no energy. It is neither moving, nor giving off heat, nor emitting light. From a purely sensory point of view, visitors could conclude that a candle that is not burning is without energy.

Creating a mood for the demonstration of energy in things is crucial. A darkened area is very important. It is also a good idea to have the students in a circle at a safe distance from the candle.

Here are two possible ways to present this demonstration. All of the students in the class could act out the role of the visitors while you take the role of the wise person from earth. As an alternative, one student could act as the earth representative with five students acting as visitors and the rest of the class observing the meeting and recording their observations. The observers could also pass judgement on the authenticity of the meeting, with two or three of the observers concentrating their observations on each of the visitors, and at the conclusion, giving a short description of how well each visitor played the role and how realistic his/her comments concerning the candle and its energy really were.

There are two main conclusions that should be reached and discussed at the end of this activity:

1. Some substances have energy within them called "chemical energy".

2. Chemical energy can usually be observed when it converts to other forms through such means as burning.

Further discussion might focus on linking the chemical energy of the candle to the earth's ultimate energy source, the sun. It could be pointed out that the candle is made of paraffin, a substance derived from oil. Oil is a fossil fuel that developed from marine organic material that was alive hundreds of thousands of years ago and that obtained its energy from the sun. The sun's light energy was converted through photosynthesis to chemical energy, which was locked into the complex molecules of the material's tissues. A similar story can be used to trace the origin of numerous products that we take for granted.

Follow-up Activities

1. Have students make a list of all the things they can think of in five minutes that contain chemical energy. If you establish that plants are the source of chemical energy, it might help students to lengthen the list.

2. Have students consider and write a sentence or two describing the advantages of having chemical energy stored as a solid (e.g., in a candle, in wood, or in coal), as a liquid (e.g., in oil or gasoline), or as a gas (e.g., in natural gas).

3. Ask students what the disadvantages of having objects made of substances containing chemical energy are. Have them give examples of things that could *not* be made out of substances that contained chemical energy (e.g., a stove, an engine, a light bulb).

4. Inform students that oil, gasoline, coal, and gas are substances that contain vast amounts of chemical energy. Have students devise ways to best store each such energy substance in a safe way.

Related Activities

1. Energy conversions also take place involving energy forms other than chemical energy. Demonstrations can be done to illustrate the following energy conversions:

– Kinetic energy can be changed to heat by quickly rubbing three fingers back and forth against a smooth pad of paper or other slippery surface. Discussion could lead to explanations of rope "burns" and the like.

– The same conversion is possible by pressing the palms together and rubbing briskly.

2. The energy in foods can be demonstrated by using a few burnable items such as dried noodles or macaroni. A single piece of macaroni placed on the tip of an unfolded bobby pin, needle, or piece of wire will hold a flame and burn for about ten seconds when ignited with a match or candle. *When working with open flames, maintain strict control of the demonstration, making sure that students keep safely away. Keep adequate supplies of water or other extinguishing devices close at hand.*

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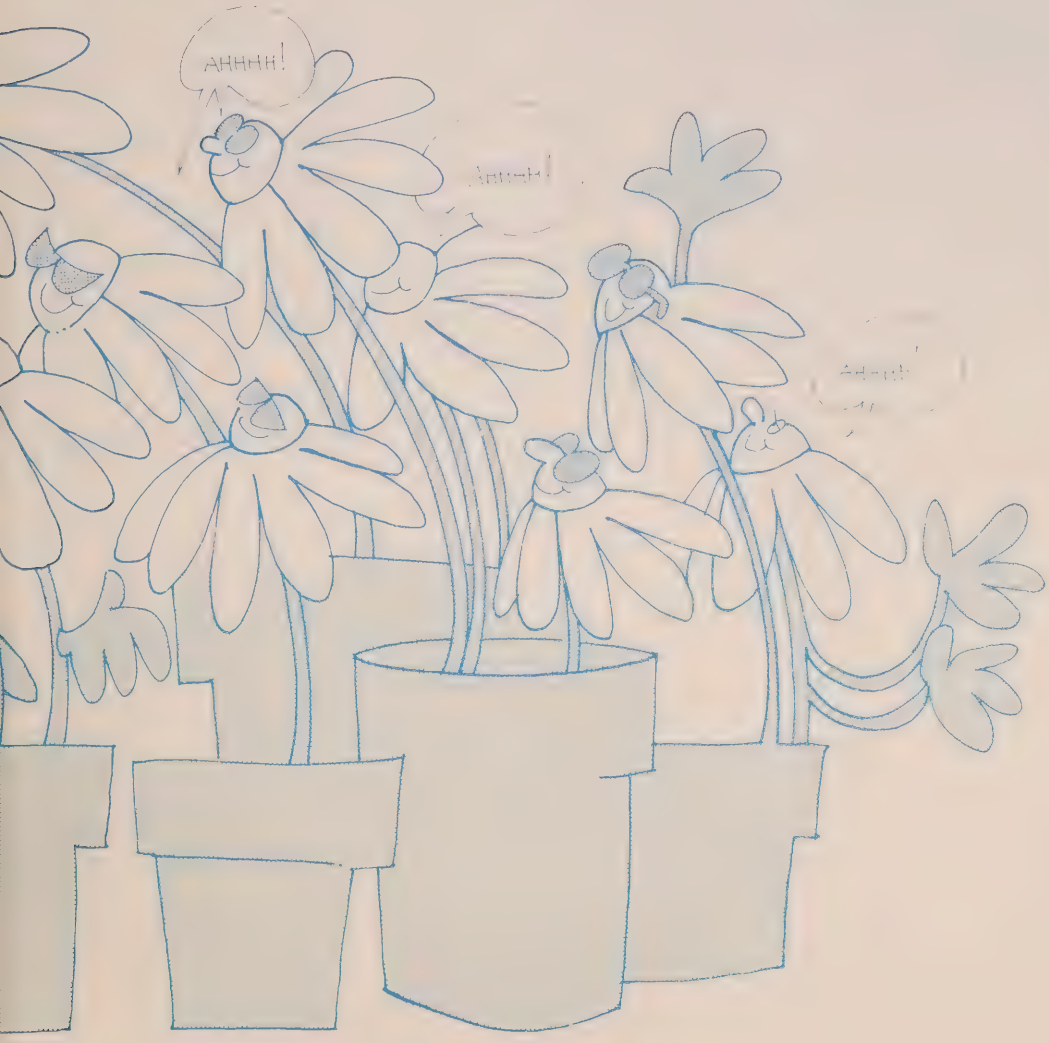
Brackenborough, E. F., et al. *The Methods of Science 4*. Toronto: Clarke, Irwin and Co., 1963.

Wilson, M., and the editors of *Life*. *Energy*. New York: Time Incorporated, 1963.

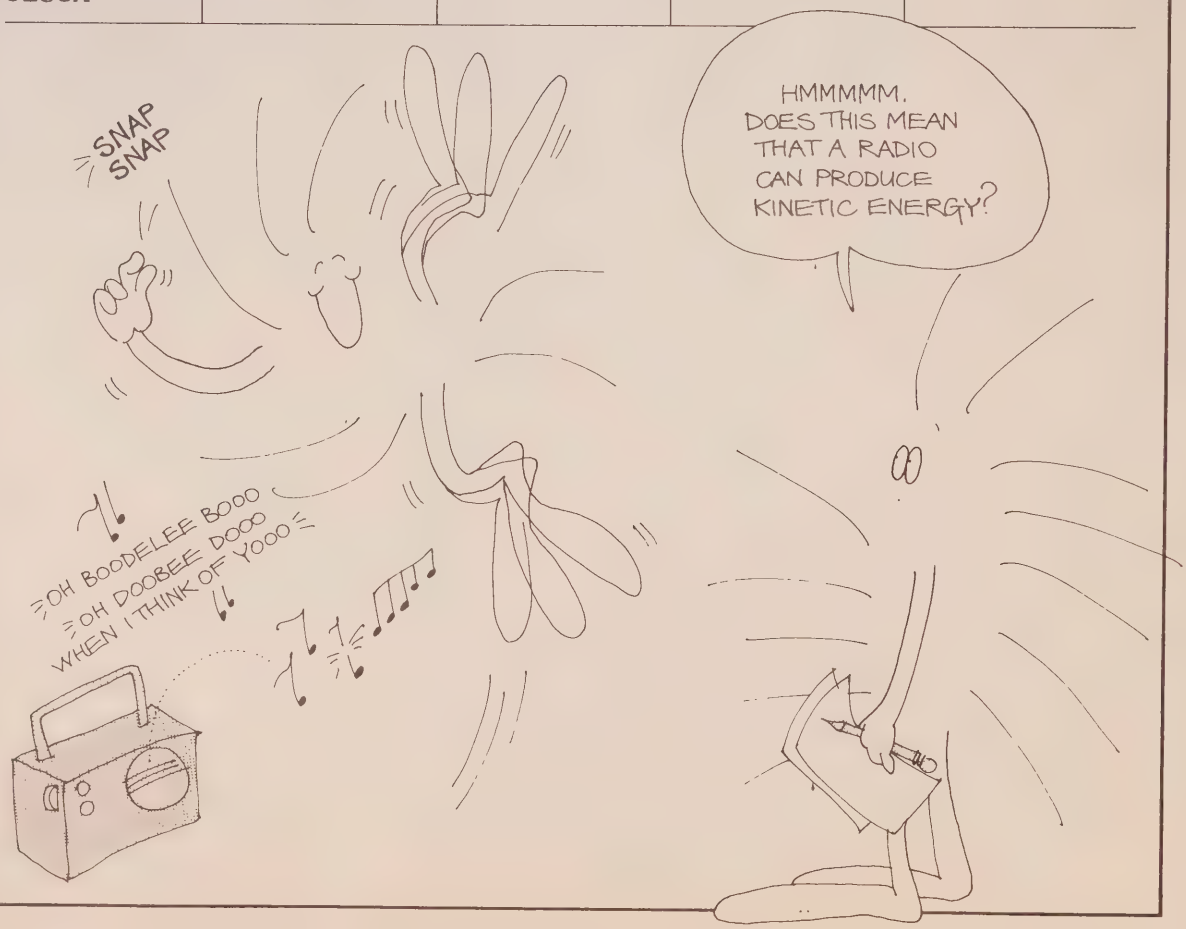


Name:

Electrical Appliances Convert Energy

You are about to look at some familiar objects that are found in homes. They all use electricity. Although you cannot see the electrical energy, you can see the energy forms that have been converted from the electrical energy. For each item, check off the types of energy that you are able to see and that demonstrate that electrical energy must have been present in the first place.

Observable Forms of Energy				
Electrical Gadget	Motion	Heat	Light	Sound
Toaster				
Lamp				
Fan				
Radio				
Clock				



Notes

To gain an understanding about the physical basis of electricity, it is necessary to consider atoms and atomic structure, topics that are best left for higher grade levels. The information that follows is mainly for your consideration as teacher.

Atoms are made up of three types of particles – electrons, protons, and neutrons. Electrons and protons have equal and opposite charges whereas neutrons have zero charge. Atoms generally have equal numbers of electrons and protons so that the total negative charge of the electrons balances the total positive charge of the protons. Thus, overall the atom is neutral in charge.

An atom cannot lose protons but it can lose electrons. This leaves the atom with more positive charges than negative ones, thus giving it an overall positive charge. It is then called a "positive ion". Similarly, some atoms can gain one or more extra electrons to become negatively charged ions. The movement of electrons is a key feature of electrical phenomena.

"Static" electricity can be created by rubbing together certain unlike substances. In the process electrons from the atoms of one substance may be given up to the other substance leaving the first substance positively charged (having lost electrons) and the second substance negatively charged. Since opposite charges attract one another, the build-up of electrons on the one substance may become so great that the electrons will "spark" across from one substance to another, transported through the atoms in the air. This is one instance where an electrical phenomenon can be made visible. An electrical storm is another visible display of the same sort created by an electron flow through a massive spark.

Some substances such as metals and impure water freely conduct electrons from atom to atom. For this reason they are called good conductors of electricity. Other substances do not allow for the movement of electrons. They are called poor conductors of electricity and they can be used as insulators.

Humans have devised instruments that cause the build-up of electrons in a controlled manner. The generators in a hydro- or thermal-electric station are examples of such instruments, but the mode of their operation is too complex to be described here.

A dry-cell battery is another example. The electron movement in the dry cell results from chemical reactions between the substances inside the battery. One part of the dry cell gains electrons while another part loses them. If a wire and flashlight bulb are attached to the battery as illustrated on page 14, electrons will flow through the bulb and wire from the negative to the positive part of the dry cell. When electrons pass through the filament of the bulb, it becomes very hot and gives off light and heat energy that can be seen and felt.

The release of chemical energy from substances like candle wax, paper, or wood can be safely viewed, felt, or heard when the proper precautions are taken. However, it is not safe to experiment with household electrical energy. To touch a bare electrical wire in a household circuit is to unleash the energy through your body. But just as the presence of energy in wax was observed when the candle was lit, so can the presence of electrical energy be observed when it passes through such things as light bulbs, toasters, and frying pans.

The activity sheet has students looking for observable forms of energy in the small appliances and gadgets around the home. When electrical energy is converted through motors, heating coils, or moving wheels, it is transformed into motion, light, heat, or sound energy, each of which can be observed.

Bring into the school a variety of household appliances, such as a lamp, frying pan, toaster, hair dryer, fan, space heater, radio, clock, blender, electric toothbrush, or electric razor. Have students try to observe the visible energy forms after the electrical energy conversion has taken place for each appliance. The student worksheet is to be used as a check sheet. (Further written observations could go elsewhere.) Only five appliances are listed, but students should make a similar chart on the back of the activity sheet and list ten additional appliances and the associated forms of energy for each.

Note of caution: Light, sound, and motion can be observed without the use of hands. Sensing the presence of heat may require contact. Be sure to unplug an appliance before testing for heat. Do not allow students to feel items that you yourself have not tested or that should not be touched. Any "hands-on" activity with electrical appliances should be done as a teacher-controlled demonstration, with strict supervision.

Follow-up Activities

1. Discuss with your students how some substances act as conductors of electrical energy while others are non-conductors. Then have students examine and possibly take apart a 10 cm piece of extension-cord wire, and describe its detailed structure in terms of conducting electricity. Basically they should be looking to see how insulation is used to prevent the electricity transferred through the wires from sparking to other objects.

2. Have available for examination and use a number of dry cells of different sizes and shapes up to and including a 6 V flashlight dry cell. Attach two nichrome or two copper wires to each dry cell. One wire should be attached to the positive contact and one to the negative contact. (Use masking tape if necessary.) Remember, do not touch the two wires together; if you do the dry cells will lose their energy. Have students test the brightness that is possible when a flashlight bulb (and other small bulbs, if available) are touched with the wires. (To make the filament in the bulb glow, one wire should touch the metal side of the bulb, while the other wire touches the metal contact at the very end.) The students should get some understanding about how the bulb's brightness is related to the amount of energy required to make the filament radiate light.

3. If some old (possibly broken) household appliances (e.g., a toaster or iron) can be obtained, have students do an appliance dissection to see what the "insides" have in common.

Related Activities

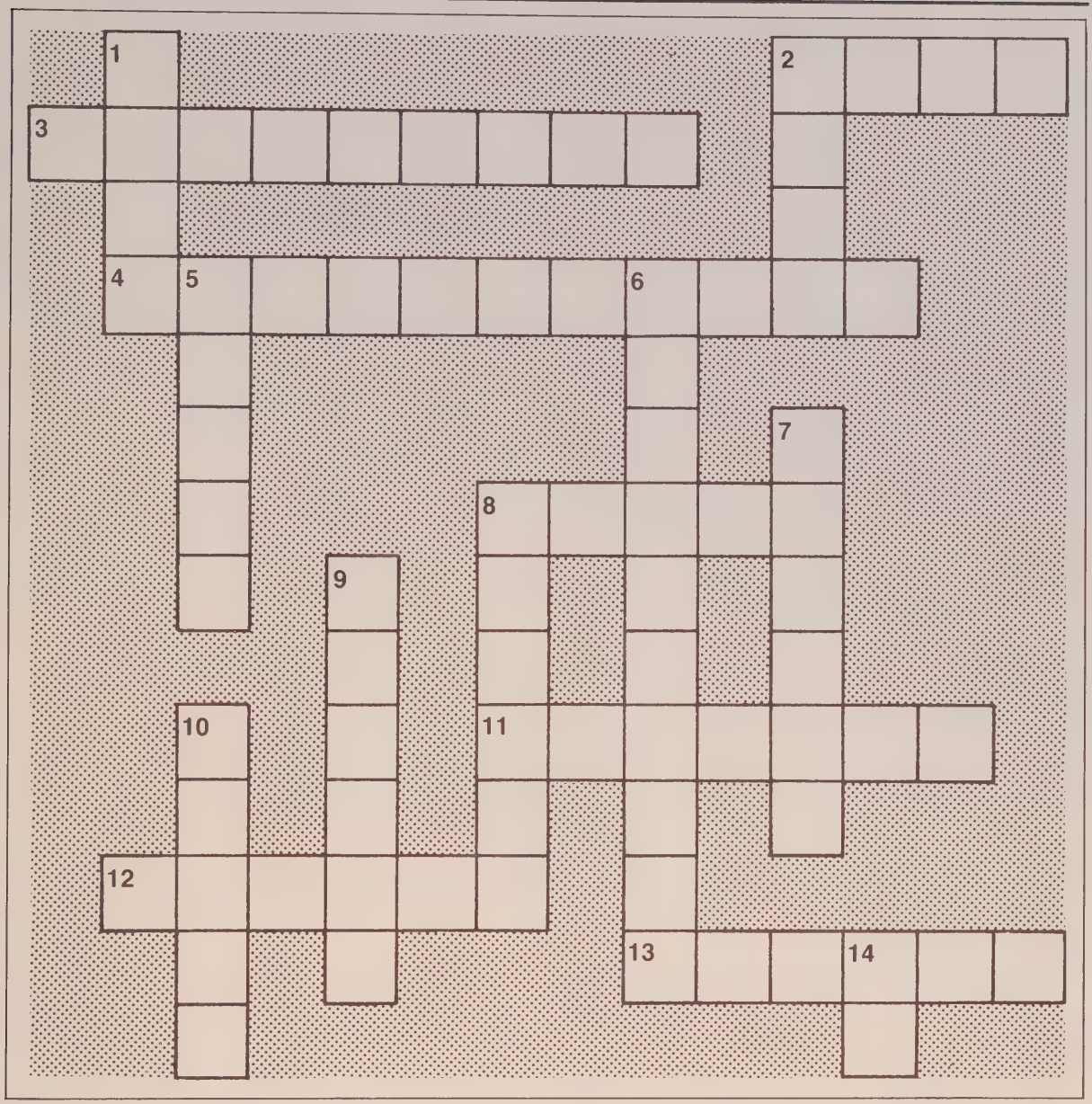
1. With your class try a word-association activity for the word "electricity". Have the students write the word "electricity" at the top of the page and then attempt to record one word for each letter of the alphabet – each word somehow relating to electricity.

2. Have students attempt to complete the crossword puzzle on page 25. It employs many of the words associated with electricity.

References

Andrews, W. A., et al. *Science 10.* Toronto: Copp Clark Pitman, 1967.

Paige, C. R. *Heat and Electric Energy.* Toronto: Holt, Rinehart and Winston of Canada, 1975.



Down

1. The long, thin material that carries electricity. (*wire*)

2. The type of energy released from electricity in an electrical stove oven. (*heat*)

5. We use bulbs to produce this in the dark. (*light*)

6. All substances that transmit electricity are called _____. (*conductors*)

7. You must twist a light bulb into a _____ to make it work. (*socket*)

8. The insulation of many electrical cords is made of this material. (*rubber*)

9. Electricity is a form of _____, as are heat and light. (*energy*)

10. You may hear or see this while combing your hair. (*spark*)

14. An electrical appliance with a glass screen. (*TV*)

Across

2. When plugging in electrical appliances, take care not to get an electrical shock in this part of your body. (*hand*)

3. Nature's greatest display of electrical energy. (*lightning*)

4. The word we most often use when referring to electrical energy. (*electricity*)

8. The electrical gadget we use to listen to music and news. (*radio*)

11. An object that produces and stores electrical energy. (*battery*)

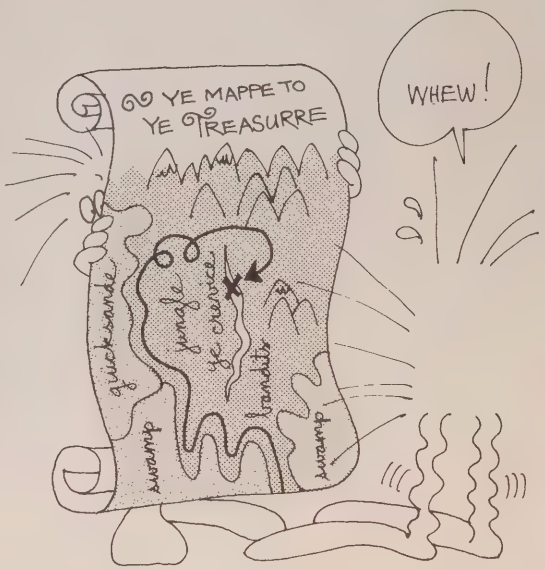
12. A word of warning that could be printed on many electrical things. (*danger*)

13. To turn the lights on you would have to look for this. (*switch*)

Name:

Build a Potential Energy Device and Make a Billion

You and your partner get a copy of a map that shows you the way to a treasure of jewels worth a billion dollars.



The treasure was discovered originally in one of the most hard-to-reach jungles of the world. No one has found a way to get the treasures out. The reason is that the jewels are in a very heavy iron box. The box is in a deep crevice. The crevice is the home for deadly snakes, spiders, and scorpions. There is deadly gas near the bottom as well. No one can enter the crevice even though the box can be seen from the top.

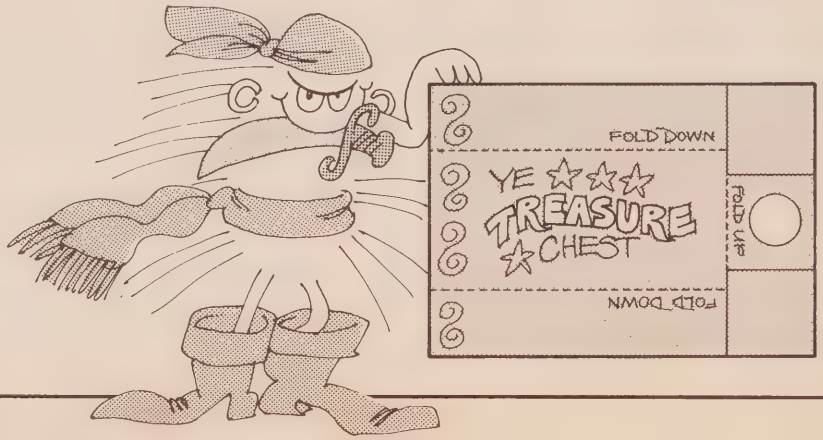
The only way to reach the area is by a secret trail that takes many weeks of hiking.

It would normally take ten strong people to haul the box out. This is much too large a group to secretly enter the region without being caught by local bandits protecting the treasure.

You and your partner must do it alone, with only a small amount of equipment that you carry in. Your problem is to find a way to haul out the heavy iron box without ever going into the crevice.

You plan to make a potential energy device! All you take on your hike are two long ropes, two hooks, and an axe to cut down some trees. No one else has thought of this idea. Can you do it?

Use the materials that your teacher gives you to show how the potential energy device would work.



Notes

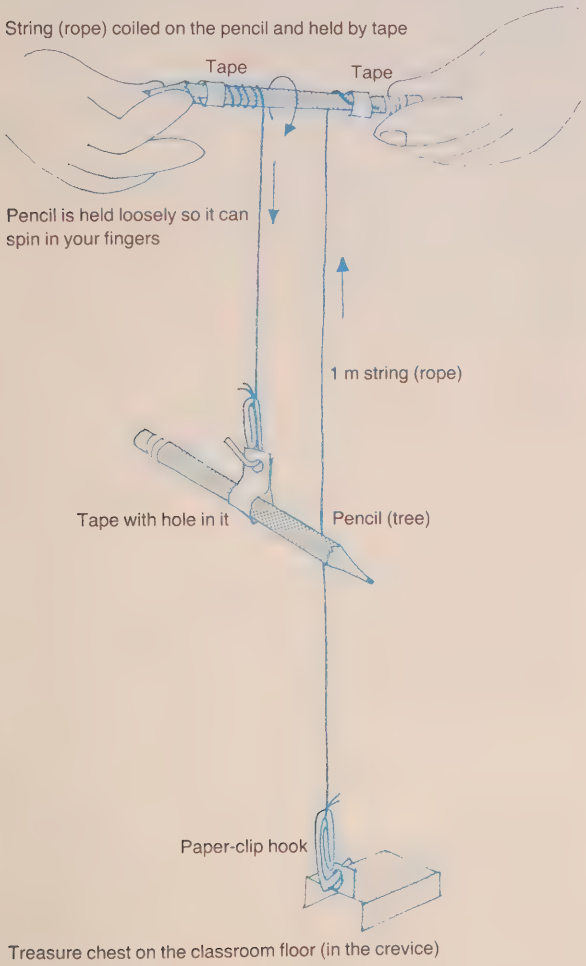
This activity should be fun. It is a "Mission Impossible" activity packed with adventure and intrigue, *if* you take advantage of the description.

First, it might be worth carefully reading, with your students, the description on the activity sheet. You may embellish the story if you wish. The question then becomes: What is a "potential energy device"? Remember, a great deal of energy is going to have to be used to get the box out of the deep crevice. No engines or regular machines can be carried so far into the jungle. Only the materials described can be taken on the trip – some rope, two hooks, and an axe.

Next, give to each pair of students scissors to cut out and fold the treasure boxes (making sure that the handle hole is cut out), two 1 m pieces of thread (to represent the rope), two pencils (to represent trees), two paper clips (to use as hooks), and some tape (for fastening the thread to a pencil).

Tell the students what each piece of equipment represents. You might even illustrate a potential energy device that is partly constructed, as shown in the accompanying illustration.

Potential Energy Machine



To simulate the crevice, have students place their "treasure boxes" on the floor. Their desk tops represent the top of the crevice. All activity must take place from the desk top. Give them ten minutes to figure out how the potential energy machine might work.

The accompanying diagram shows how the potential energy of the second pencil (the tree) is used to raise the treasure from the classroom floor. It is not expected that the students will figure this out on their own. Their solutions, if they have any, should be checked carefully to see if they would work in the real situation.

After their first effort at a solution, stop them long enough to explain the meaning of "potential energy". Illustrate it by holding a pencil and asking if it requires energy to break the point. Of course it does! If you were to use your strength to break it, you would use some of the chemical energy stored in your body. But you could use the potential energy already in the pencil. Just by releasing the pencil it starts to move, being attracted to the earth by gravity. When you drop the pencil, its gravitational potential energy changes to kinetic energy, until it reaches the floor. In crashing to the floor, the tip could be broken. Thus, the potential energy the pencil had to start with could be used to break the tip.

Things not resting on the ground possess such potential energy. As an object falls, its potential energy is changed to kinetic energy. We might call gravitational potential energy "energy of position".

You might also explain that an object held higher has more potential energy. (Dropping the pencil a short distance may not break the tip.) As well, a heavier object at the same height has more potential energy than a lighter object. (Tying something heavy to the pencil would be more likely to cause the tip to break.)

The only difficult thing to do in completing the task is to hook the paper clip on the end of the unwound string onto the handle of the treasure box. Once the box is hooked, the first pencil (simulating a tree lying across the crevice) should be held loosely so that the second pencil has a chance to slowly fall to the floor (go down into the crevice). The treasure box will simultaneously be drawn up to the desk top. Note that, once started, the device works on its own. No finger motion should occur.

Because the potential energy machine operates practically like a toy, students should enjoy using it once they figure out how it works. Discuss with the students how potential energy is used to bring out the treasure. There are different forms of potential energy. A coiled spring, a loaded rifle, or a litre of gasoline all have the potential to do work. They all have potential energy. To simplify the presentation to your students only the potential energy of position or "gravitational potential energy" has been considered in this activity set.

When an object is raised against gravity, energy is required. Of course, the greater the distance the object is to be raised or the heavier it is, the more energy will be required to lift it. The energy used to raise the object, whether derived from an electric motor or your own muscles, is converted to potential energy and is retained by the object as long as the object is held in the elevated position. The potential energy of an object can be converted back when it once again returns to ground level. This release of energy is first seen as kinetic energy (of motion) as it falls to the ground.

In the Mission Impossible activity, the trees near the crevice mouth possessed potential energy, since gravity could cause them to fall into the crevice (and give up their energy of position). Anyone wishing to obtain the treasure simply needed a pulley system to make use of the potential energy in a heavy tree.

One trunk placed across the crevice and anchored so that it can spin in its position represents a crude pulley. When a rope is wrapped around this tree trunk and the loose end is attached to another tree trunk to be lowered into the crevice, a device capable of drawing the treasure out is created.

One of the most important forms of potential energy for us is that possessed by droplets of rain high in the air. The energy required to raise water in the form of water vapour originally comes from the sun. Radiant solar energy originally causes evaporation and the movements in the air masses that take water vapour to higher elevations.

When rain drops fall and pool in lakes and rivers at high altitudes, the water still retains a good deal of potential energy. It can still fall farther in its course to the sea. As river water flows downhill, its potential energy changes to kinetic energy and can be used to turn water wheels (such as those used formerly in mills) or generators to make electrical energy. Hydro-electric energy is still a very important source of generated electricity in Ontario.

Follow-up Activities

1. Describe a situation in which someone wishes to build a log cabin on the top of a mountain covered with large, heavy boulders. On the top of the mountain there is only one tree (represented in this activity by a pencil). At the bottom of the mountain there are many trees. Using five stones brought in from outside, five pencils on the floor, and the potential energy machine, have students haul "trees" to the top of the mountain (their desk tops) one after another.

2. Have students try to figure out how the very heavy "draw bridges" that lay across the moats of old castles might have been operated by one person using a potential energy device.

Discuss the use of potential energy devices in such things as cuckoo clocks and elevators in tall buildings. (The latter have counterbalancing masses so that only a small motor is required to operate the heavy elevator car.)

3. a) Have students answer the questions in the test on potential energy on page 29.

(The following are the answers to the above questions: 1b, 2b, 3b, 4a, 5c, and 6a.)

b) Have students make their own test questions to give to the rest of the class in an oral quiz game.

Related Activities

1. Attach a string to one of the ceiling fixtures in the classroom. Make sure the string is long enough to hang within a few centimetres of the floor. Attach an object such as a small stone or piece of metal to the string. Raise the object to one side like a large pendulum. Discuss with the class the potential energy present in the object. Release the object and show how the potential energy becomes kinetic energy and then becomes potential again as it reaches the height of its swing.

2. Have the students make a list of natural objects that have potential energy by virtue of their position. Some examples include trees, leaves, boulders on mountains, birds flying, dust in the air, flying insects, raindrops in clouds, and water in elevated lakes and rivers. A similar list of human-made objects or things containing potential energy could be developed as well.

3. Have students look around the classroom to identify those things that possess potential energy by virtue of their position. The students could attempt to order the objects in terms of the most and the least potential energy, considering both the mass and height of the objects.

Name:

What Has the Most Potential Energy?

The following are descriptions of things that possess different amounts of potential:

There are sets of three things to compare in each case. Write "most" in the space beside the thing that has the most potential energy and "least" beside the thing that has the least potential energy.

1. a) a ball held 1 m from the ground _____
   b) a ball held at the height of your nose while you are standing _____
   c) a ball held at the height of your nose while you are lying down _____

2. a) an apple held 1 m from the ground _____
   b) a large watermelon held 1 m from the ground _____
   c) a grape held 1 m from the ground _____

3. a) 10 L of water in a bucket on the ground _____
   b) 1 L of water in a bucket held over your head _____
   c) 1 L of water in a bucket held at your waist _____

4. a) a green football kicked 40 m onto the school roof _____
   b) a brown football kicked 100 m along the ground _____
   c) a red football thrown 60 m along the ground _____

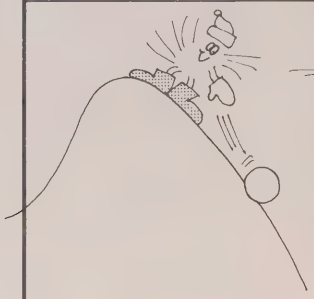
5. a) 6 nickels in your pocket when you are standing _____
   b) 6 dimes in your pocket when you are sitting _____
   c) 6 quarters in your pocket when you are standing _____

6. a) a cannonball in a plane 5 km high _____
   b) a feather in a plane 5.1 km high _____
   c) a baseball in a plane 5.1 km high _____

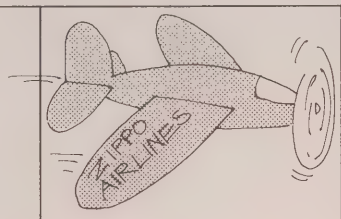
Name:

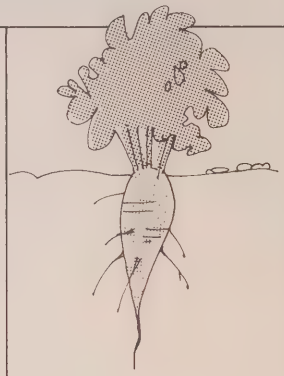
Sensing Energy Around Us

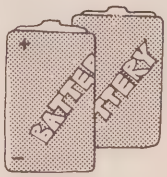
You should now realize that energy exists in many forms and can be found in nearly everything around us. The pictures below illustrate different things that possess different forms of energy. Some things (probably most) contain more than one form of energy. Under each picture write in block letters (BLOCK LETTERS) the major energy form, and in small letters (small letters) other forms of energy that are also present. Your energy choices are: kinetic, heat, light, sound, chemical, electrical, and potential energy.

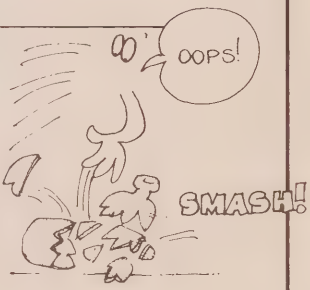


POTENTIAL
kinetic









Notes

If at the completion of this unit your students know that energy comes in many forms and can be converted from one form to another, then consider this unit a success. This last activity set should determine how clearly your students understand the different forms of energy and whether they can identify them in everyday situations.

The physical/chemical basis for energy is not something you should expect your students to have learned. Molecules and atomic structure, which hold the secrets to energy, can be studied at higher grade levels when students are able to cope with the complexity of these topics.

This rather straightforward activity is designed to complete the unit in summary fashion. Your students have to consider all the energy forms together. Have them work in teams of three or four so that there are a total of eight teams. Give each team a number.

The teams should work together to complete their worksheets. The real value in the exercise will come through the discussion that takes place over each picture. There will undoubtedly be differences of opinion, but within their teams students should agree on their choice of answers to record.

Deal with each picture in turn. Place the numbers from 1 to 8 in a hat and draw from the hat the number of the team that is to give its ideas concerning the types of energy portrayed in the first picture. Other teams will get a chance to comment during the take-up session.

Note that both major and minor energy forms are illustrated in each picture. The following answers might be expected:

1. ***snowball:*** potential energy (height); kinetic energy (rolling); very small amount of sound energy (contrasted with an avalanche, which can be very loud);

2. ***airplane:*** potential energy (a large mass at a great height); kinetic energy (flying); chemical energy (remaining fuel); heat energy (the engine heat); sound energy (the roaring jet engine); various energy forms within the plane;

3. ***candle:*** chemical energy (the burnable wax and wick); heat energy (in the flame); radiant energy (from the flame); possibly a tiny amount of sound energy if it crackles;

4. ***carrot:*** chemical energy (the food aspect); heat energy (any object not at absolute zero, -273°C, contains heat energy);

5. ***bird:*** kinetic energy (bird's flight); potential energy (position above ground's surface); chemical energy (the energy stored in the food and the chemicals in the bird's body).

6. ***battery:*** chemical energy (within the battery the potential to make electrical energy from the chemicals exists); potential energy (because of its position on the shelf);

7. ***street lamp:*** radiant energy (from the light filament); heat energy (from the hot filament wire); electrical energy (from the wire connections); potential energy (height of the post and lamp above ground);

8. ***bottle:*** kinetic energy (the flying pieces); sound energy (vibrations during shattering); potential energy (until the pieces lie on the floor).

Follow-up Activities

1. Have students make their own illustrations similar to the ones shown. After the pictures are completed, have pairs of students exchange their pictures to guess the major energy forms being illustrated.

2. Have students cut out magazine pictures that illustrate the presence of two or more forms of energy and label them to go on an energy bulletin board.

Related Activity

Have the students play the Energy Game. The rules for the game follow, as does the gameboard. Two, three, or four students can play at a time. Each needs seven coloured tabs or pieces of paper, one to use as a marker and six as energy units (explained in the rules). A single die is needed for each gameboard.

Following the game you might have students consider how energy is wasted and other ways by which more energy can be gained.

Rules for the Energy Game

The object of the game is to move a marker around the gameboard from the "start" position to the "finish" position. A die is rolled to move the marker. The game is over when one player reaches the "finish" position.

At the start of the game each player (up to four) has six energy units. An energy unit is simply a token or slip of coloured paper, which is used to signify a quantity of energy. If the marker lands on a square that says "costs one energy unit", that player must give up one energy unit and place it on the "finish" square.

If a player has lost an energy unit (and is thus left with only five) and if the die is then rolled and a six turns up, the player cannot move. Similarly, if second and third energy units are lost, leaving only three energy units, only rolls of one, two, or three are acceptable. Near the end of the game energy units can be regained. However, any player can have only six energy units while moving around the gameboard, and can never have less than one.

The person finishing first picks up all of the energy units on the "finish" square. Scores are then computed by counting the number of energy units in the possession of each player.

Five rounds of the game are considered a match, and the scores for each round are totalled to determine a match score. At the beginning of each new round each player starts with six energy units.

15 OIL SPILL GO BACK TO 10	14	13 LIGHTS LEFT ON IN CAR GO BACK TO 10	12	11
16	29 BUY SMALLER CAR TO SAVE GAS GAIN 1 ENERGY UNIT	28 GROW YOUR OWN FOOD GAIN 1 ENERGY UNIT	27 BUILD A SOLAR COLLECTOR GAIN 1 ENERGY UNIT	10
17 WASTED ENERGY GO BACK TO 16	30	35 finish	26	9 GAS TANK LEAKS COSTS 1 ENERGY UNIT
18	31 WASTED ENERGY GO BACK TO 23	34 WASTED ENERGY GO BACK TO 23	25	8 BUY AN AIR CONDITIONER COSTS 1 ENERGY UNIT
19 WASTED ENERGY GO BACK TO 16	32	33 WASTED ENERGY GO BACK TO 23	24	7 FORGET TO TURN OFF LIGHTS COSTS 1 ENERGY UNIT
20	21 REFRIGERATOR DOOR LEFT OPEN COSTS 1 ENERGY UNIT	22 OVEN LEFT ON BY ACCIDENT COSTS 1 ENERGY UNIT	23	6 FOOD IS WASTED COSTS 1 ENERGY UNIT
1 start here	2 ENERGY GAME	3	4	5 WASTED ENERGY GO BACK TO 3

Glossary

absorption. The taking in or reception of radiant energy.

atom. The smallest particle of an element, made up of a particular number of protons, neutrons, and electrons. The basic building blocks of all substances, atoms cannot be broken down further by chemical means.

conduction. The transfer of heat or electrical energy through a substance.

convection. The transfer of energy by moving masses of matter, such as in the circulation of liquids and gases.

conversion. The process of changing one energy form into another.

electricity. A form of energy present in protons and electrons.

electron. An elementary particle carrying one unit of negative electrical charge. Electron movement in a conductor constitutes electricity.

energy. The capability of doing work.

filament. The threadlike, often coiled metal conductor in a light bulb, which is raised to incandescence by the passage of current.

infra-red. Invisible radiation with a wave length greater than that of red light.

insulation. A substance that slows down the flow of heat or sound.

kinetic energy. Energy possessed by moving objects.

mass. A measure of the amount of material in an object.

molecule. The smallest portion of a substance that can exist by itself and still retain the substance's properties.

neutron. An uncharged elementary particle that is found in the nucleus of an atom and that has a mass equal to that of a proton.

noise. Sound, usually of a loud, harsh, or confused kind which has no value aesthetically.

organic. Originally pertaining only to those chemicals derived from living things, but now expanded to mean all compounds containing carbon.

photosynthesis. The chemical process in plants that converts the radiant energy of sunlight into chemical energy using carbon dioxide and water molecules in the process. The resultant chemical energy may be stored in the plant as sucrose.

potential energy. Energy that is stored in a substance. One form of potential energy is gravitational potential energy, which is possessed by objects that can fall or travel closer to the earth's surface.

proton. An elementary particle with a positive charge equal to the negative charge of an electron but with a mass equal to a neutron. Protons are found in the nuclei of all atoms.

sound energy. A kind of energy carried by vibrating molecules which spreads out in wave fashion.

ultraviolet. Radiant energy outside the violet end of the visible spectrum which has a wave length shorter than radiant light energy.

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